

The impact of kinesiology tape application on the volume of interstitial space over the gastrocnemius within healthy mixed-gender participants using ultrasonography

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Abstract

Purpose: The purpose of this study was to analyze the impact of kinesiology tape application on the volume of interstitial space over the gastrocnemius within healthy mixed gender participants using diagnostic ultrasound.

Materials/methods: A lab-based experiment was conducted involving thirty healthy participants 26.5 ± 8.5 who volunteered to take part in this study with no previous injuries. Participants were randomly allocated to either the kinesiology group, Zinc-oxide or no tape group. Kinesiology tape was applied through the "I Strip" technique. Each application comprised of a 10 cm piece of tape applied at the mid-point of the gastrocnemius, at a 50% stretch (7.5 cm each side). The interstitial space was recorded at this point using the Real Time Diagnostic Biosound Ultrasound machine. The tape was applied for twenty-four hours and the interstitial space was re-measured. Same methodology was repeated for those in the Zinc-oxide and the no tape group.

Results: A one-way repeated measures ANOVA test reported a significant difference in the volume of interstitial space between the no tape and KT group and the KT and Zinc oxide group for both initial and 24-hour readings ($p=0.002$, $p<0.000$). Paired t-tests between the initial and after 24-hours readings revealed no significant differences showing that there was no further increase of the interstitial space after 24 hours.

Conclusions: The application of the kinesiology tape increases the interstitial space within healthy participants a twenty-four hour application. Further research should take place in relation to the different applied tensions of the tape and the impact this has upon the volume of interstitial space.

Level of evidence: 1c.

Introduction

Developed in 1973, Kinesiology Tape (KT) was created as a method of stabilizing joints, as well as facilitating movement and muscle function [1]. KT has gained a tremendous amount of popularity in the last decade. With varied different applications of the product this has become a very popular training and therapeutic tool to enhance patient health.

KT can not only be used in sporting environments for strength, stability and power but also in ordinary day to day life, for improved circulation and recovery which is appealing to a wider population [2]. KT can facilitate muscle function, reduce pain and increase the range of motion for joints and skeletal muscle [1]. All of these benefits, along with proprioception, assisting venous circulation and lymphatic drainage, serve to enhance healing [3]. Resulting in an enhanced recovery rate and improved quality of life. For the purpose of this study, emphasis was upon measuring the effect of KT on interstitial space.

KT was developed in order to replicate the thickness of the epidermis, encouraging muscle facilitation and range of motion. When any form of restriction is applied to the skin, mechanoreceptors in the area sense a change in the environment, relaying a message to the brain via sensory receptors [4]. The KT manual, states that the tape has been created so that following approximately ten minutes from application the patient will no longer be aware of the tape on their skin [1]. Founders claim that the tape can be left on for around 3-5 days.

This is a huge benefit to the overall product performance, as the patient is not inhibited or restricted and can function normally aiding an active recovery.

Interstitial space is a dynamic matter completely surrounding cells and capillary walls that aids the body's homeostatic function [5]. The fluid enables nutrients and waste products to be delivered appropriately in order to maintain a healthy equilibrium within the tissues. This is vital for cell nourishment and allowing the surrounding tissue to metabolize and allow optimal function [6]. Currently there is a lack of published literature on factors impacting on the total volume of interstitial space. However, there is significant research focusing on lymphedema and lymphatic drainage, particularly relating to breast cancer patients (post treatment) relating to the application of KT between 2-8 weeks [7]. Due to the removal of the lymph nodes, lymphedema is a common end product as a result of cancer treatment. With the lymph nodes removed, excessive oedema can be present in the tissues [8] The 'lifting' effect,

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kinesiology taping has on the skin from the muscle is one of the claimed attributes of the tape [1]. As a result of this, the volume of interstitial space is increased.

KT's ability to be applied relaxed or under tension created controversy of how the tape is most effectively applied. Kase, Wallis & Kase [1] suggest 50-60% but a study by Lumbroso, Vered & Kalichman [9] suggests otherwise finding significant differences at 30%. Time is also a matter to be considered, Kase, Wallis & Kase [1] suggest that for optimum effect for the tape, it should be worn for 3-5 days, however the manual does not provide any clinical based evidence. Previous studies [10,11] both reported significant effects of KT post 24 hours of application, creating an uncertainty for clinicians when prescribing KT as a method of treatment. Due to the lack of research and contradictory results of previous papers. The objective of this study was to examine and report the effect of KT application on the volume of interstitial space of the gastrocnemius immediately after and over twenty-four hours. The clinical benefit of this study will be to provide evidence based information to healthcare practitioners regarding the use and application of KT on the gastrocnemius in case of an edema due to injury.

Methods

Design

This study is a double blinded randomized clinical trial with a comparison of a no tape group and two intervention groups with a total of thirty participants. The independent variable of this study are the interventions, the kinesiology and zinc oxide groups and the dependent variable is the interstitial space measured (mm).

Participants

Approval was granted from the Research Ethics Committee (REC) of our University before any testing had commenced. Thirty healthy participants were recruited from a large London university campus through the use of posters placed around the site as well as word of mouth. All participants (fifteen male and fifteen female) were over the age of eighteen to ensure that full physical maturity had been achieved and they were able to provide their own consent [12]. Participants were limited to a maximum age of thirty-five years due to the age profile of health declining [13]. The aim when recruiting the participants was to have the same anthropometric characteristics, recording the age, height and weight of each of the participants. Table 1 presents the inclusion and exclusion criteria required for participant engagement. The sample size was determined by previous studies which found significant differences when using the same number of participants [10,11].

Interested parties were given forty-eight hours to study the participant information sheet given regarding the research in order for them to decide whether they wish to continue with the study. Once the participants were recruited, they were given an informed consent form to complete. The participants were randomized into groups using an online tool (Random Team Generator) into no tape, KT and zinc oxide tape. The no tape group acted as the control group and the KT and zinc oxide groups were the intervention.

Procedures

30 participants were randomly allocated via an internet-based randomization service to either the kinesiology group, Zinc oxide or the no tape group. The testing procedure was replicated on each participant within each group. A patch test was conducted before any of the testing

commenced to ensure the participants did not experience any adverse effects to the tape [14]. The same leg (dominant) was used on each participant for reliability purposes, similarly to a study conducted with inhibitory KT method on the gastrocnemius [15].

The KT application group was given the 'I strip' technique shown in Figure 1, applied from the KT manual [1]. Each application comprised of a 10 cm piece of tape applied at the mid-point of the gastrocnemius, at a 50% stretch (7.5 cm each side). The stretch was applied from origin to insertion in order to facilitate the muscle action. With the zinc oxide intervention group a 15 cm piece was applied, shown in Figure 2. Zinc oxide has been used for many years to provide stability to joints because of its high tensile strength [16]. Due to the lack of stretching qualities of the tape it was applied at the mid-point of the muscle [17].

The Real Time Diagnostic Biosound Ultrasound, transducer head LA523 was used to display the different layers under the skin, specifically the interstitial space. The LA523 transducer head was used in this study, its features include having high frequency imaging to be able to scan small parts especially the peripheral vascular system. The transducer head was 4 cm by 0.5 cm in surface area.

Maintaining the same position, measurements were recorded after the initial application and 24 hours later. The ultrasound gel enabled clear imaging on the screen, which was then frozen in the correct place to facilitate recording of measurements. Screenshot from the ultrasound machine is shown in Figure 3. All measurements were taken from the left side on the midpoint of the tape.

The results were recorded by a sports therapist (not the principal investigator) who was trained and experienced in tape application

Table 1. Inclusion and Exclusion criteria for participation in this study

Inclusion criteria	Exclusion criteria
<ul style="list-style-type: none"> • Non-gender specific • 18-35 years old • Generally active and healthy • English Speaking 	<ul style="list-style-type: none"> • Any past or present injuries or pathologies in the lower extremity • People that present with a lack of sensation or feeling • Pregnancy • Malignancy • Ehlers-Danlos Syndrome—presenting with hypermobile joints/skin laxity¹² • Deep Vein Thrombosis (present or suspected) • Skin Allergies specific to tape adhesive or the ultrasound gel



Figure 1. Kinesiology tape I Strip application. The middle line shows the mid-point of the gastrocnemius measured on each of the participants included in this study. The top and bottom line are 7.5 cm distance apart from the central line, stretching the tape 50% of its resting length



Figure 2. Zinc oxide application. The middle line shows the mid-point of the gastrocnemius measured on each of the participants included in this study. The top and bottom line are 7.5 cm distance apart from the central line, the tape is 15 cm in length, the same as the kinesiology tape

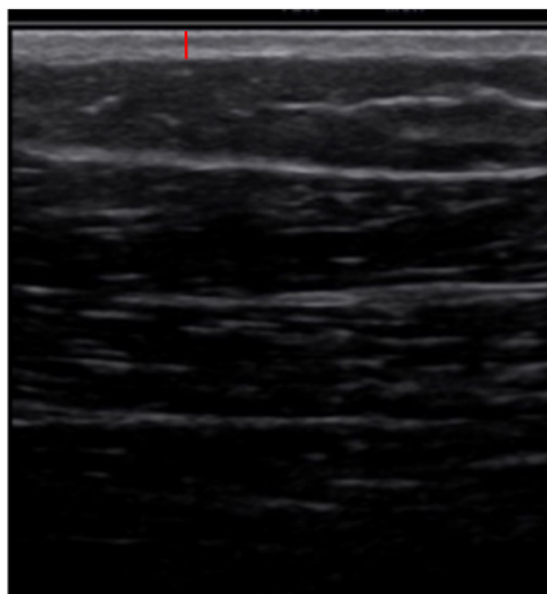


Figure 3. Screenshot taken from the Real Time Diagnostic Biosound Ultrasound, showing the space measured between the skin and the muscle – the interstitial space. The red line indicates where the measurement was taken

and the use of ultrasound equipment. The study was conducted using double-blind conditions as the participants and the investigator were not aware of the aims of the treatment they were receiving or the study objectives. This influences the study's reliability and decreases the level of bias. The intervention groups had measurements recorded, tape applied, and twenty-four hours post application. Each of the of these measurements were repeated three times therefore, enabling the calculation of an average score eliminating any measurement bias. All data was stored in encrypted software (one drive) where only the researcher had access.

Statistical analysis

The software SPSS version 25.0 was used in order to examine the data in this study. The one-way repeated measures ANOVA test was conducted in order to compare each intervention group against one

another. The p value was set at 0.05. The characteristics including the age, height and weight of all the participants were compared using an independent samples t test.

Results

47 individuals had expressed a willingness to participate, however 17 candidates were unable to attend the second session, therefore, they were excluded from this study.

A total of 30 participants completed this study, there were no further withdrawals. The sample consisted of, 15 male and 15 females, aged 22 ± 2 years, height 167 ± 4 and weight 58.5 ± 2.5 . They all attended the university laboratories between the 12th June–3rd July 2019 and tested over a 24-hour period. No significant difference between the groups were revealed after comparing the individuals age, height and weight. Data were tested for normality by the Shapiro Wilk test ($N=30$) and were normally distributed.

The one-way ANOVA statistical tests showed that there was a significant difference within the groups for both initial and 24-hours readings (initial $p=0.002$, 24h $p \leq 0.000$) in relation to the volume of interstitial space measured (Table 2 reports the descriptive statistics). In order to identify between which groups there were these significant differences post-hoc tests were conducted.

When the post-hoc comparisons were analyzed using Tukey's tests, the results showed that there were significant differences between the no tape and KT groups ($p=0.007$) and the KT and Zinc oxide groups ($p=0.003$) in the initial readings. The post 24-hour readings showed similar differences between the no tape and KT groups ($p=0.001$) and the KT and Zinc oxide groups ($p \leq 0.000$). No differences were found between the no tape and Zinc oxide tape (Table 3).

Table 2. One-way repeated measurements ANOVA. Immediately after and post 24 h measurements

Groups	Mean values	Standard deviation	Std. Error
NT initial reading	1.807	± 0.178	0.046
NT 24-hour reading	1.846	± 0.141	0.036
KT initial reading	2.027	± 0.226	0.058
KT 24-hour reading	2.120	± 1.234	0.060
ZO initial reading	1.783	± 0.156	0.040
ZO 24-hour reading	1.800	± 0.158	0.041
Initial reading between groups			$p=0.002^*$
24-hour reading between groups			$p=0.000^*$

NT: No tape; KT: Kinesiology tape; ZO: Zinc oxide; *: Significant result.

Table 3. Tukey's tests between groups

Groups	Significant difference between groups (Tukey's test)
NT initial reading KT initial reading	0.007*
KT initial reading ZO initial reading	0.003*
NT initial reading ZO initial reading	0.939
NT 24-hour reading KT 24-hour reading	0.001*
KT 24-hour reading ZO 24-hour reading	0.000*
NT 24-hour reading ZO 24-hour reading	0.775

NT: No tape; KT: Kinesiology tape; ZO: Zinc oxide; *: Significant result.

All the groups final mean results showed an increase in interstitial space between the initial and 24-hours readings. The KT group presented the greatest increase by 4.95% whereas the no tape group concluded a 2.2% increase and the Zinc oxide only by 0.97%. However, paired t-tests between initial and 24-hour readings showed that none of these differences were significant. This shows that there was no further increase of the interstitial space after 24 hours. In, addition, the standard error of measurements (SEM) was small and provided a perfect reflection of the true scores.

Discussion

The objective of this study was to determine whether the use of KT had an impact on the volume of interstitial space over the gastrocnemius. The results showed that there was a significant difference between the no-tape and KT groups and the KT and ZO groups in both initial and after 24 hours readings. Some studies have posed the argument that KT potentially creates a similar effect in comparison to a Zinc oxide application those using the product [18]. The Zinc oxide effect influences the person who is receiving treatment which they believe to have a beneficial factor to the body [19]. Although this is not directly linked to the treatment properties of the product, the Zinc oxide effect encourages individuals to build belief and reassurance in the treatment process. A study conducted over a 24-hour period on 19 college students with no blinding or Zinc oxide group compared the effects of KT on isometric muscle strength [20]. The results presented that there were no significant differences after the 24-hour period and in further study a sham condition would be effective in analyzing the potential effectiveness of the tape for muscle strength. The featured study is double-blinded and has a Zinc oxide group present, this decreases the characteristics shown in a Zinc oxide effect as well as ensuring that the results are more reliable.

According to the KT manual, the tension of the tape impacts the therapeutic effect and use of the product. The current version indicates that for improved circulation or lymphatic correction the tension of the tape should be between 0-20% stretch, using multiple overlapping fan strips in order to reduce the oedema [1]. It is stated in the manual that if there is more than 50% tension, the tape is more likely to recoil and pull back to the anchor point [1]. However, a study conducted investigating the effectiveness of KT at a 50% stretch on the quadriceps muscle found this to be non-effective in altering the neuromuscular performance of the muscle [21]. After the study had concluded, it was considered in the discussion that the quadriceps muscle does not directly influence the balance of ankle joint, the muscles surrounding the ankle joint have a direct influence on the balance and control. Despite this result relating to the physiology of the muscle, this tension may be better suited to oedema management. This could only be identified if a future comparative study was to be conducted to contrast different tensions, highlighting the most effective method for increasing interstitial space. In this study, similarly the KT was stretched by 50% of its original resting length, which is referred to as severe tension to analyze the impact this has on the volume of interstitial space.

Many studies have been conducted on KT over a varied timespan. A study focusing on the application of KT and exercise-induced muscle damage showed that KT is effective during 24-hours post exercise to promote a faster recovery after eccentric exercise [22]. Other studies that support the use of KT over 24 hours, [10,11] have found significant effects of KT reducing pain in the neck and shoulders post 24-hour

application ($p=0.01$ and $p=0.05$). These results are not largely within the significance scale; therefore, this was a primary factor as to why this investigation retested over the same 24-hour period. Although the studies were investigating KT and pain relief, they are essential to consider their methodology due to the pain relief experienced being a result of KT decompressing subcutaneous nociceptors through the increase of interstitial space [11,12]. This study compared the immediate and 24-hour post taping effects; however, it is suggested by Kase, Wallis & Kase [1] that the tape is most effective 3-5 days after application. This highlights another intervention method for future consideration when retesting due to the lack of supporting research regarding time scale, along with the low significance of the 24-hour intervention within this investigation.

Dynamic tape is a new biomechanical tape that has properties unlike KT, like its longitudinal and transverse (4-way) stretching ability, covering a larger surface area [23]. Dynamic tape can be applied across a joint in a shortened position, as an anchor point to improve the motion, function and load of that joint [24]. Ryan Kendrick the founder of dynamic tape believes that unlike KT, the tape can be stretched 200% of its resting length with no rigid end point and provides strong resistance measured at 10-15 kg with correct application [25]. Investigation into this new taping product in comparison with KT could be valuable in assessing which product increases the interstitial space greater for the entire muscle.

Limitations

One of the main limitations of this investigation was that the tape in both groups was applied in the "I strip" technique taken from the KT method. The "I Strip" method is used to limit pain in an acute injury setting. If additional study was to take place, other techniques that are outlined within the KT manual could be investigated, compared and contrasted. This would enable the techniques to be assessed in a clinical setting, therefore identifying the more efficient technique for the appropriate scenario. Lymphatic taping techniques such as the fan strip and the web technique are outlined in the KT manual referred to as the space correction method [1]. This method assists fluid movement in congested areas specifically indicated for patients with seroma formation [26].

The method of measurement used in this study was the diagnostic ultrasound. The reliability of ultrasound has been frequently compared against magnetic resonance imaging (MRI). The MRI is often referred to as a powerful tool for recognizing and diagnosing several different pathologies in clinical science [27]. Despite the MRI being recognized as the gold standard for diagnostic imaging, to the majority of studies this is something that is not available or obtainable due to cost. Any abnormalities in a dynamic movement can be detected through the use of ultrasound whereas the static MRI may not pick this up so successfully [28].

Another alternative method of measuring interstitial space, would be the extraction of the fluid from the space [29]. A study analyzing tissue fluid volume, extracted venous blood samples. Following activity showed an increase in volume when compared to pre-activity results. This was an early research study, in which the method had its limitations. Being an invasive method of measuring, this could potentially introduce the risk of infection and deter some individuals from participating in the study. Therefore, with multiple variables in mind, accuracy, simplicity, cost and safety, ultrasound is the most reliable and versatile option for diagnostic imaging [30].

Conclusions

Through the analysis of the results from this study, it is concluded that there is a significant increase in interstitial space with the use of KT over a 24-hour period. The findings of this study agree with the conclusions from a literature review [31] that KT is an effective complementary technique in the reduction of lymphedema as part of breast cancer aftercare. This study provides evidence-based data to assist allied-health practitioners in managing individual rehabilitation programs where an increase in interstitial space of the gastrocnemius may be beneficial such as in a case of edema due to injury. This would have a significant effect on the recovery speed and quality of life of the patient. Further investigation is recommended utilizing different stretch variables and duration.

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Conflicts of interest

No potential conflict of interest relevant to this article was reported.

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